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Final Technical Report

# (U) TEST PLANNING FOR IN-PLACE HARDNESS DEMONSTRATION

## Volume V
## SELECTED LF SUBSYSTEMS TEST PLAN

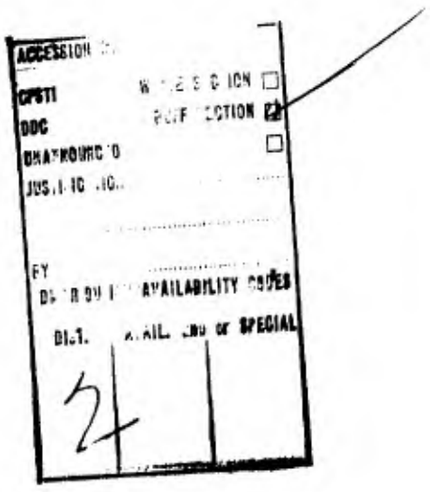
Air Force Contract F04694-67-C-0134

Prepared By
TRW Systems Group
Redondo Beach, California

15 February 1968



Prepared For
Department of the Air Force
Headquarters, Space and Missiles Systems Organization
SMNP-1
Air Force Systems Command
Norton Air Force Base, California

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## FOREWORD

(U) This document is the final technical report of the Test Planning for In-Place Hardness Demonstration Study submitted to SAMSO/NAFB in January 1968. This study was conducted by the Systems Support Group, Science and Technology Department of TRW Systems Group, Redondo Beach, California, for the Space and Missile Systems Organization, Air Force Systems Command, Norton Air Force Base, California, under Contract No. F04694-67-C-0134, dated 1 June 1967.

(U) The study effort covered by this report was initiated in June 1967 and completed in February 1968. The United States Air Force management control for this task was provided by Mr. C. B. Totten, SMNP-1. Technical direction was provided by Mr. S. Italia and Mr. C. R. Smith, Weapon Systems Division, Aerospace Corporation, San Bernardino Operation.

(U) Mr. C. K. Stein was TRW Systems Group's project engineer for this study and was responsible for attaining its overall objectives. Mr. J. P. Bednar (TRW) and Mr. J. Karagozian (consultant) were co-authors of the Final Technical Report.

(U) "Information in this report is embargoed under the Department of State International Traffic in Arms Regulations. This report may be released to foreign governments by departments or agencies of the U. S. Government subject to approval of Space and Missile Systems Organization (SMSDI), Los Angeles AFS, California, or higher authority within the Department of the Air Force. Private individuals or firms require a Department of State export license."

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(U) This technical report has been reviewed and is approved.

Charles B Totten

Charles B. Totten
Project Officer
Resources, Planning and Programming Division
Directorate of Civil Engineering

## UNCLASSIFIED ABSTRACT

This study has developed a test program plan for demonstrating the in-place hardness of an advanced ballistic missile weapon system. A test requirements analysis methodology was devised, utilizing a systems approach, to examine a WS-120A system baseline design with respect to a given weapons effects environment criteria, define the testing required to assure hardness of each system element, trade off applicable simulation techniques, and recommend a series of test concepts. These concepts were then logically combined into efficient and cost-effective in-place hardness demonstration test programs for the launch facility and launch control facility.

This report has been divided into five volumes and classified as follows:

| | |
|---|---|
| Volume I | Study Report Summary (Unclassified) |
| Volume II | Methodology (Unclassified) |
| Volume III | Test Requirements Analysis (Secret, RD) |
| Volume IV | Test Program Plan (Unclassified) |
| Volume V | Selected LF Subsystems Test Plan (Unclassified) |

CONTENTS

ILLUSTRATIONS

# 1. INTRODUCTION

## 1.1 PURPOSE

The purpose of this LF Subsystems Test Plan is to prescribe a test program that will provide high confidence in the capability of critical Launch Facility subsystems to withstand the simulated air blast and direct induced effects of a high overpressure environment.

## 1.2 SCOPE

This document outlines the requirement for the Test Program, describes the LF system elements to be tested, and prescribes test objectives and success criteria. It also identifies the controlling test documentation, specifies test program tasks and designates how and when they will be accomplished.

## 1.3 BACKGROUND

In order to assure high confidence in the hardness of the LF, a series of hardness demonstration tests have been prescribed by the LF Hardness Demonstration Test Program Plan. LF system elements basic to the hardness of the system are those that have been identified as critical subsystems. These include the silo structural shell, the main closure, MF antenna, antenna feed cable, and silo penetrations. It is essential that these subsystems withstand the air blast and ground motion effects associated with a high overpressure environment.

Since the desired environment may not be produced with nuclear devices in the atmosphere, the effects must be simulated.

The overpressure environment can be adequately simulated with a High Explosive Simulation Technique (HEST). Coupled with the overpressure pulse, direct induced ground motion effects can be simulated to some degree with the Direct Induced-High Explosive Simulation Technique (DI-HEST). The technique of coincidentally simulating the overpressure and the direct induced effects is known as HEST/DI-HEST and is described further in Section 2.

## 1.4 REQUIREMENTS FOR TESTING

The requirements for testing of the critical LF subsystem have been developed as a result of a Test Requirements Analysis (TRA) performed as part of the Test Planning for In-Place Hardness Demonstration Study. The TRA identified test requirements for each of the LF subsystem elements; however, only those associated with air blast and ground motion effects on the silo structural shell, the main closure, the UF antenna system, and silo penetrations are applicable to this Test Program. These test requirements are represented in Section 2 of this test phase as test objectives, and are further amplified with the addition of sucess criteria.

## 2. TEST DESCRIPTION

The following paragraphs describe the LF Subsystems Test Program in terms of the configuration of structural elements to be tested, the weapons effects environments to which they will be exposed, how these environments will be simulated, and the objectives of the test.

### 2.1 TEST ARTICLE

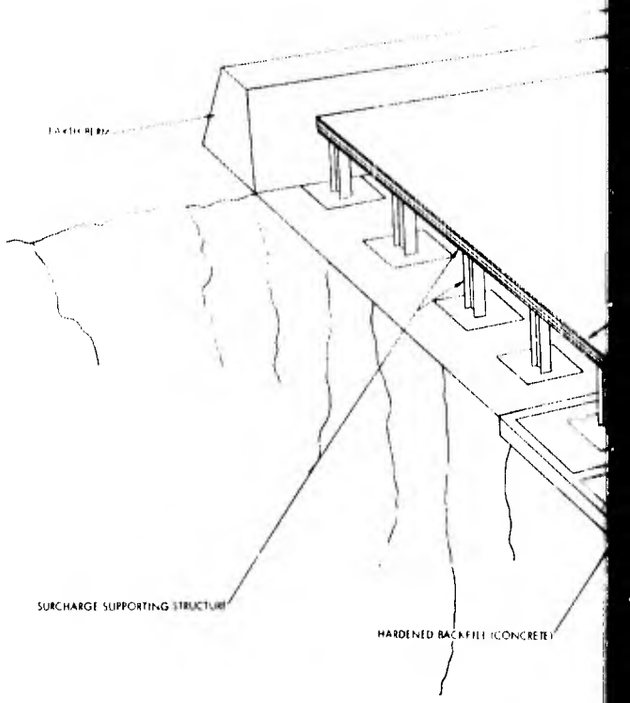
The LF subsystems to be tested are shown on Figure 2-1, and include:

a) Silo Structural Shell - A structure representative of the operational silo configuration will be provided. It will incorporate all of the structural design features of the operational silo that can be accommodated within the constraints of the test program schedule. A full scale structure is planned; however, scaling may be required in order to obtain optimum free field environment. Minimum effective scale of the structure is considered to be one quarter scale. Functional systems inside the silo will not be provided; however, space accommodations will be made so that the functional equipment can be mounted for possible subsequent testing.

b) Main Closure - The closure structure will be representative of the operational silo main closure to the degree permitted by the test program schedule. The closure will be scaled as required to match the silo structure scale. Bearing structure and seals will be provided as well as a locking mechanism. The closure actuation system will not be provided; however, space accommodations will be made in the silo structure so that it can be added for subsequent testing.

c) Penetrations - A sub-surface silo structure penetration will be provided to accommodate the MF-antenna feed cable. Other silo structure penetrations may be identified as a result of the pretest engineering and analysis. The scale of the penetrations will match the silo structure scale.

d) MF-Antenna System - A sample pattern of buried dipoles and the antenna feed cable will be provided in full scale. The pattern will not represent a full antenna array, but will include critical dipole intersections and interfaces considered to be critical.


SURCHARGE SUPPORTING STRUCTURE
HARDENED BACKFILL (CONCRETE)

A.

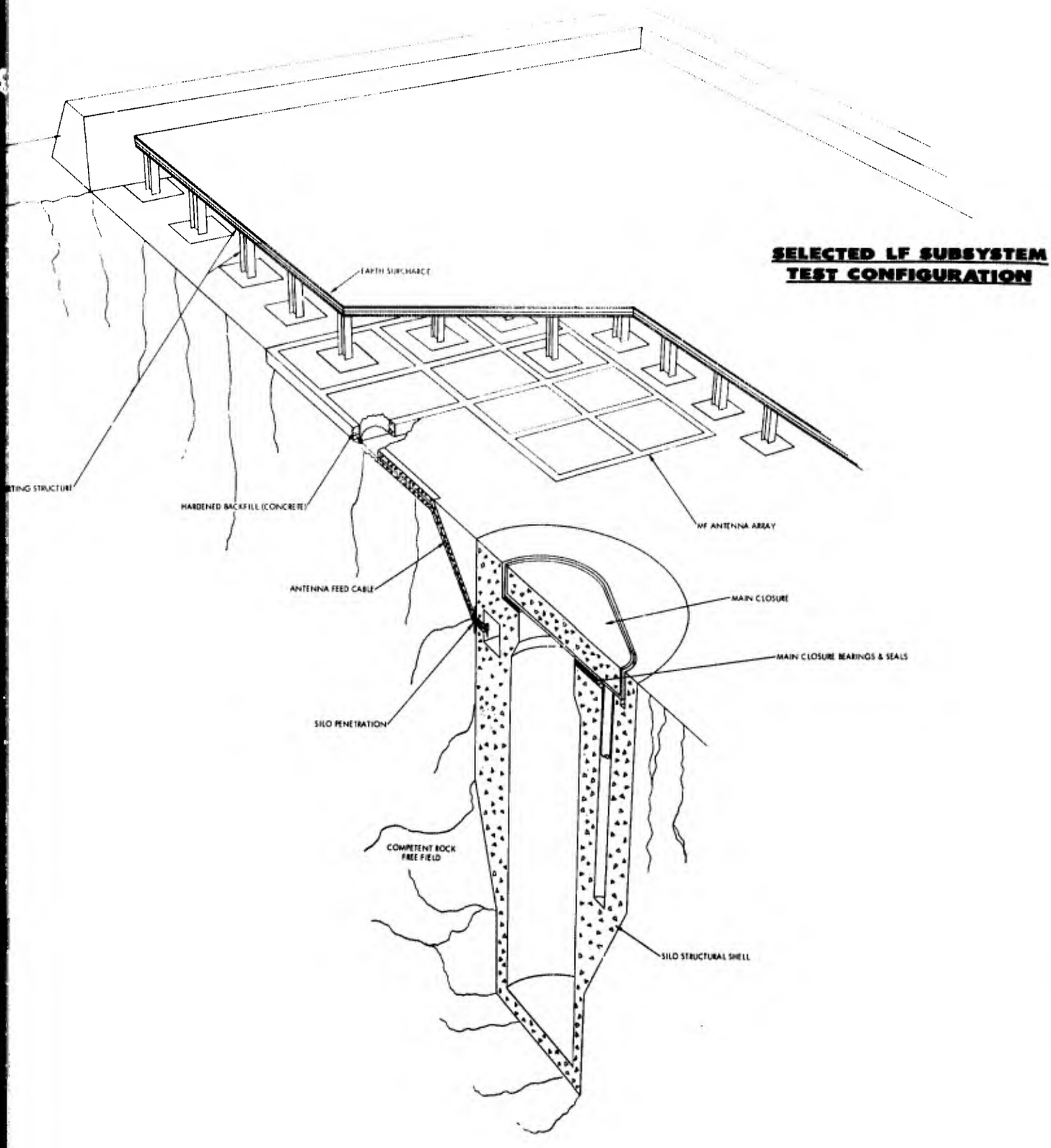



Figure 2-1. Selected LF Subsystem Test Configuration



B.

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## 2.2 CRITICAL ENVIRONMENT

The weapons effects environments critical to the LF subsystems in test are air blast; air blast induced and direct induced ground motions; and air blast induced and direct induced ground stress.

Magnitudes and characteristics of these environments will be prescribed in Figure 3-1, Free Field Environment Criteria.

The test site free field will be competent rock with characteristics similar to the operational sites as specified in Figure 3-1, Test Site Selection Plan.

## 2.3 SIMULATION TECHNIQUE

The air blast and air blast induced ground motion and ground stress environment required will be provided by the High Explosive Simulation Technique (HEST). This technique utilizes a matrix of Primacord, which, when detonated in a confined volume will provide the desired overpressure pulse. An overburden is placed over the explosion to provide a reaction force that shapes the resulting wave pulse to the required long durations. The HEST facility is depicted in Figure 2-1.

The direct induced ground motion and ground stress environment will be provided by the Direct Induced High Explosive Simulation Technique (DI-HEST). This technique utilizes a pattern of high explosive charges emplaced in a pattern of holes drilled in the free field in the vicinity of the silo structure. The charges are located in a manner such that detonation will produce the required peak velocities and peak ground stresses at the test article structure.

The HEST and DI-HEST techniques will be combined by properly phasing detonations to produce the required composite environment.

## 2.4 TEST OBJECTIVES/SUCCESS CRITERIA

The results that are expected from this test program are reflected in the following test objectives and success criteria:

Test Objective No. 1

Determine the response of the free field to the simulated weapons effects environments produced by the HEST/DI-HEST technique.

Success Criteria: Continuous measurement of velocity and acceleration transients in the free field at selected locations and at specified depths.

Test Objective No. 2

Determine strains in the silo structural shell and cavity due to air blast induced and direct induced ground stress.

Success Criteria: Continuous measurement of strain at selected critical locations in the silo structural shell and in the free field rock immediately adjacent to the structure. The measurements will be taken at selected intervals of depth from the surface to the bottom of the structure. *

Test Objective No. 3

Determine the motion response of the silo structural shell and cavity due to air blast and direct induced ground motion.

Success Criteria: Continuous measurement of acceleration and velocity at selected critical locations in the silo structural shell and in the free field rock immediately adjacent to the structure. These measurements will be taken at selected intervals of depth from the surface to the bottom of the structure. *

Test Objective No. 4

Determine the integrity of the silo penetrations when exposed to the effects of simulated ground motion and ground stress environment.

Success Criteria: Continuous measurement of strain at selected critical locations on the penetration. Pre and post test examination. Pre and post test examination and still photo data is also required.

*Note - The measurements will be taken in a manner such that the resulting data will support the analytical techniques and computer codes planned for use in verifying the pretest prediction techniques.

Test Objective No. 5

Determine the integrity of a cable or conduit through the silo penetration when exposed to the effects of the simulated ground motion environment.

Success Criteria: Continuous measurement of strain at selected critical location on the cable or conduit. The cable or conduit will be removed for inspection. Pre and post test still photos are required.

Test Objective No. 6

Determine structural integrity of the simulated MF antenna system when exposed to the effects of a simulated air blast and ground motion/ground stress environment.

Success Criteria: Continuous measurement of accelerations, velocities, and strain at selected critical locations of the concrete backfill, the radiating element, and connectors. Pre and post test electrical continuity checks, and antenna pattern checks are required. Pre and post test still photo records are also required where possible.

Test Objective No. 7

Determine strain in the main closure structure due to air blast effects.

Success Criteria: Continuous measurement of strain at selected critical locations internal to the closure structure, (in the concrete and on the steel reinforcing bars). *

Test Objective No. 8

Determine the acceleration response of the main closure to the effects of a simulated air blast and ground motion environment.

Success Criteria: Continuous measurement of accelerations on the main closure.

Test Objective No. 9

Determine air pressure leakage through the main closure bearing and seals during exposure to the effects of a simulated air blast and ground motion environment.

Success Criteria: Continuous measurement of silo internal pressure and silo/closure relative displacement.

*Note - The measurements will be taken in a manner such that the resulting data will support the analytical techniques and computer codes planned for use in verifying the pretest prediction techniques.

Test Objective No. 10

Evaluate the hardness of the test articles with respect to the criteria level weapons effects environment.

Success Criteria: Analysis of test results and extrapolation (where required) to criteria levels of weapons effects environments.

# 3. TEST PROGRAM MANAGEMENT

The following paragraphs describe the tasks to be accomplished in support of the Test Program, the test documentation that is critical to its success, and the phasing of these tasks and documents publication dates. The Test Force Organization is also defined, and the responsibilities of each participant identified.

## 3.1 TEST PROGRAM TASK OUTLINE

The tasks to be accomplished in support of the LF Subsystem Test Program are depicted in Figure 3-1, Test Program Task Outline, and are briefly described as follows:

T-1. Publish LF Subsystems Test Program Plan (Reference D-2).

This program plan will be the management device for the development, implementation and control of the proposed Test Program.

T-2. Initiate the Test Program.

Begin the development of the Test Program by briefing representatives of the test participants (military and contractor). Eligible contractors should be determined; RFP's for test integration contractor, main closure contractor and test facility A and E contractor and antenna systems contractor should be prepared and transmitted.

T-3. Establish Interagency Working Agreements.

Test Program Management and Implementation agreements must be established between SAMSO, AFSWC, AFWL and other supporting government agencies. These are to be documented and published as one of the controlling documents (Reference D-3).

T-4. Select Contractors.

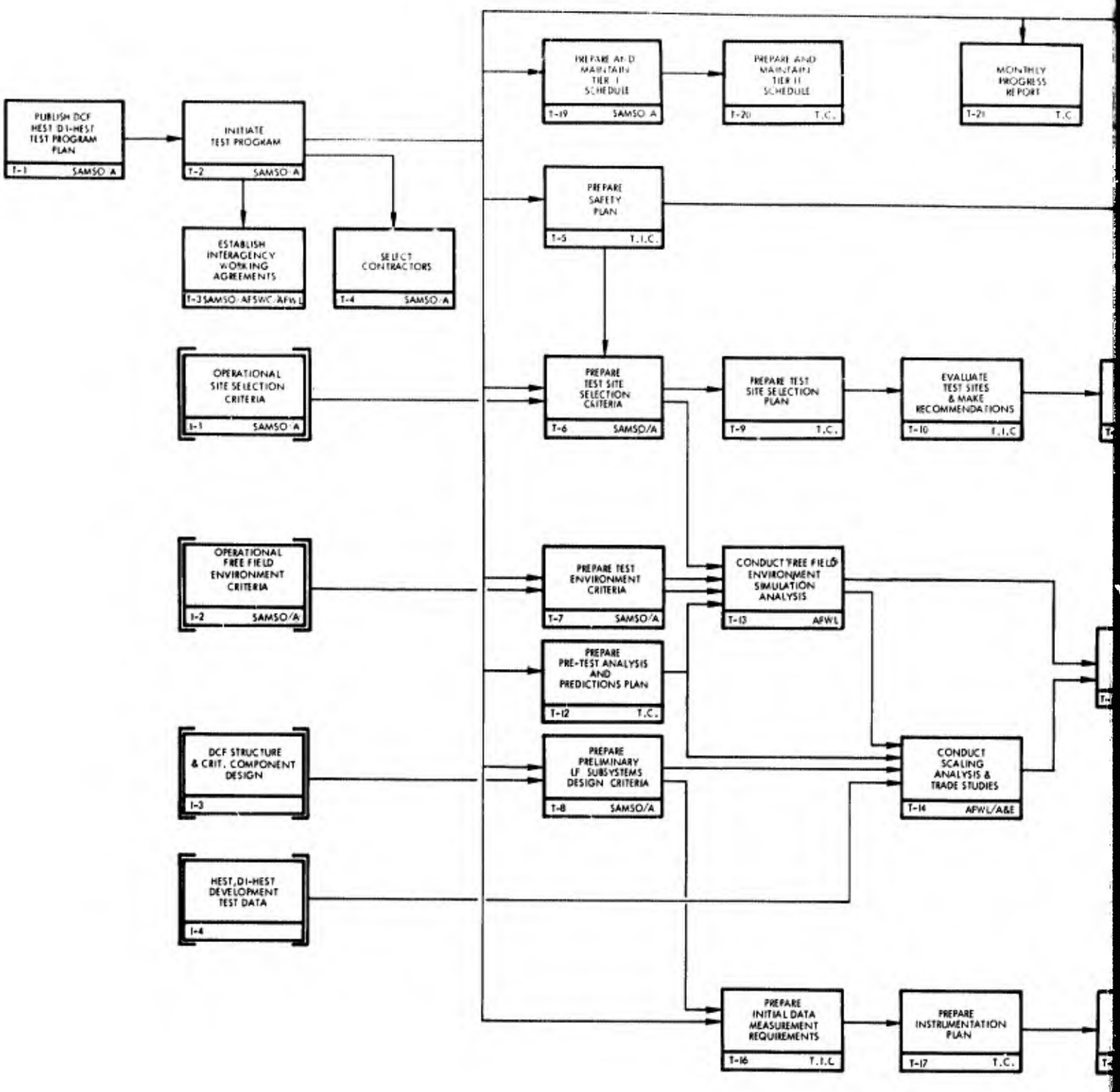
Receive and evaluate proposals from eligible contractors, select appropriate contractors, conduct negotiations and issue the required contract Statement of Work.

T-5. Prepare Safety Plan.

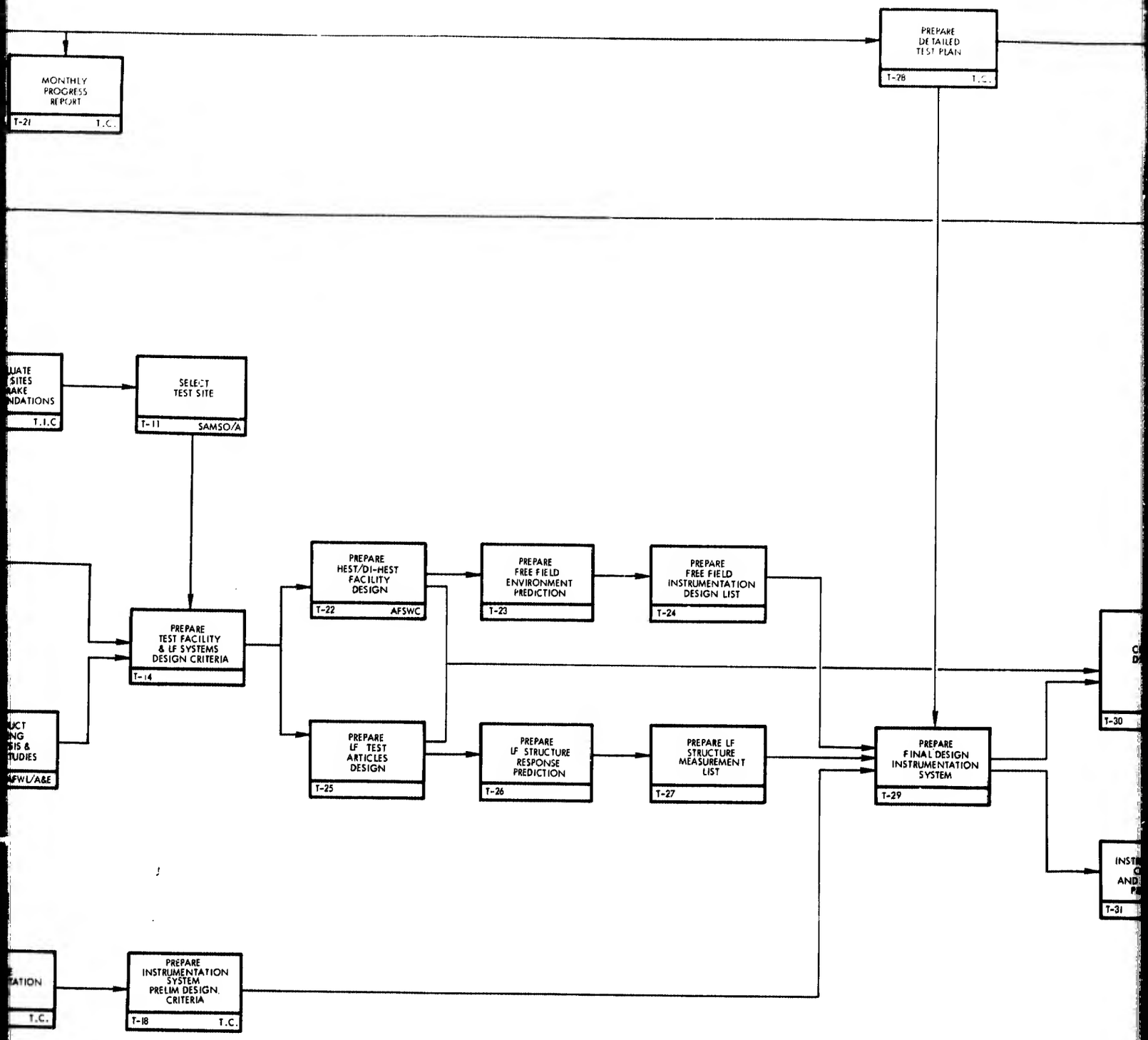
Identify the criteria for safety during all phases of the Test Program and publish a plan for achieving this required safety criteria.

T-6. Prepare Test Site Selection Criteria.

Based on the requirements specified in the operational Site Selection Criteria, the objectives of the Test Program, and safety criteria, prepare and publish a criteria that will govern the selection of the test site.


PUBLISH DCF HEST DI-HEST TEST PROGRAM PLAN
T-1 SAMSO: A
INITIATE TEST PROGRAM
T-2 SAMSO: A
ESTABLISH INTERAGENCY WORKING AGREEMENTS
T-3 SAMSO: AFSWC: AFWL
SELECT CONTRACTORS
T-4 SAMSO: A
PREPARE AND MAINTAIN TIER I SCHEDULE
T-19 SAMSO: A
PREPARE AND MAINTAIN TIER II SCHEDULE
T-20 T.C.
MONTHLY PROGRESS REPORT
T-21 T.C.
PREPARE SAFETY PLAN
T-5 T.I.C.
OPERATIONAL SITE SELECTION CRITERIA
I-1 SAMSO: A
PREPARE TEST SITE SELECTION CRITERIA
T-6 SAMSO/A
PREPARE TEST SITE SELECTION PLAN
T-9 T.C.
EVALUATE TEST SITES & MAKE RECOMMENDATIONS
T-10 T.I.C
OPERATIONAL FREE FIELD ENVIRONMENT CRITERIA
I-2 SAMSO/A
PREPARE TEST ENVIRONMENT CRITERIA
T-7 SAMSO/A
CONDUCT FREE FIELD ENVIRONMENT SIMULATION ANALYSIS
T-13 AFWL
PREPARE PRE-TEST ANALYSIS AND PREDICTIONS PLAN
T-12 T.C.
DCF STRUCTURE & CRIT. COMPONENT DESIGN
I-3
PREPARE PRELIMINARY LF SUBSYSTEMS DESIGN CRITERIA
T-8 SAMSO/A
CONDUCT SCALING ANALYSIS & TRADE STUDIES
T-14 AFWL/A&E
HEST, DI-HEST DEVELOPMENT TEST DATA
I-4
PREPARE INITIAL DATA MEASUREMENT REQUIREMENTS
T-16 T.I.C
PREPARE INSTRUMENTATION PLAN
T-17 T.C.

A.


PREPARE DETAILED TEST PLAN
T-28 T.C.
MONTHLY PROGRESS REPORT
T-21 T.C.
SELECT TEST SITE
T-11 SAMSO/A
PREPARE HEST/DI-HEST FACILITY DESIGN
T-22 AFSWC
PREPARE FREE FIELD ENVIRONMENT PREDICTION
T-23
PREPARE FREE FIELD INSTRUMENTATION DESIGN LIST
T-24
PREPARE TEST FACILITY & LF SYSTEMS DESIGN CRITERIA
T-14
PREPARE LF TEST ARTICLES DESIGN
T-25
PREPARE LF STRUCTURE RESPONSE PREDICTION
T-26
PREPARE LF STRUCTURE MEASUREMENT LIST
T-27
PREPARE FINAL DESIGN INSTRUMENTATION SYSTEM
T-29
T-30
T-31
PREPARE INSTRUMENTATION SYSTEM PRELIM DESIGN. CRITERIA
T-18 T.C.

B.

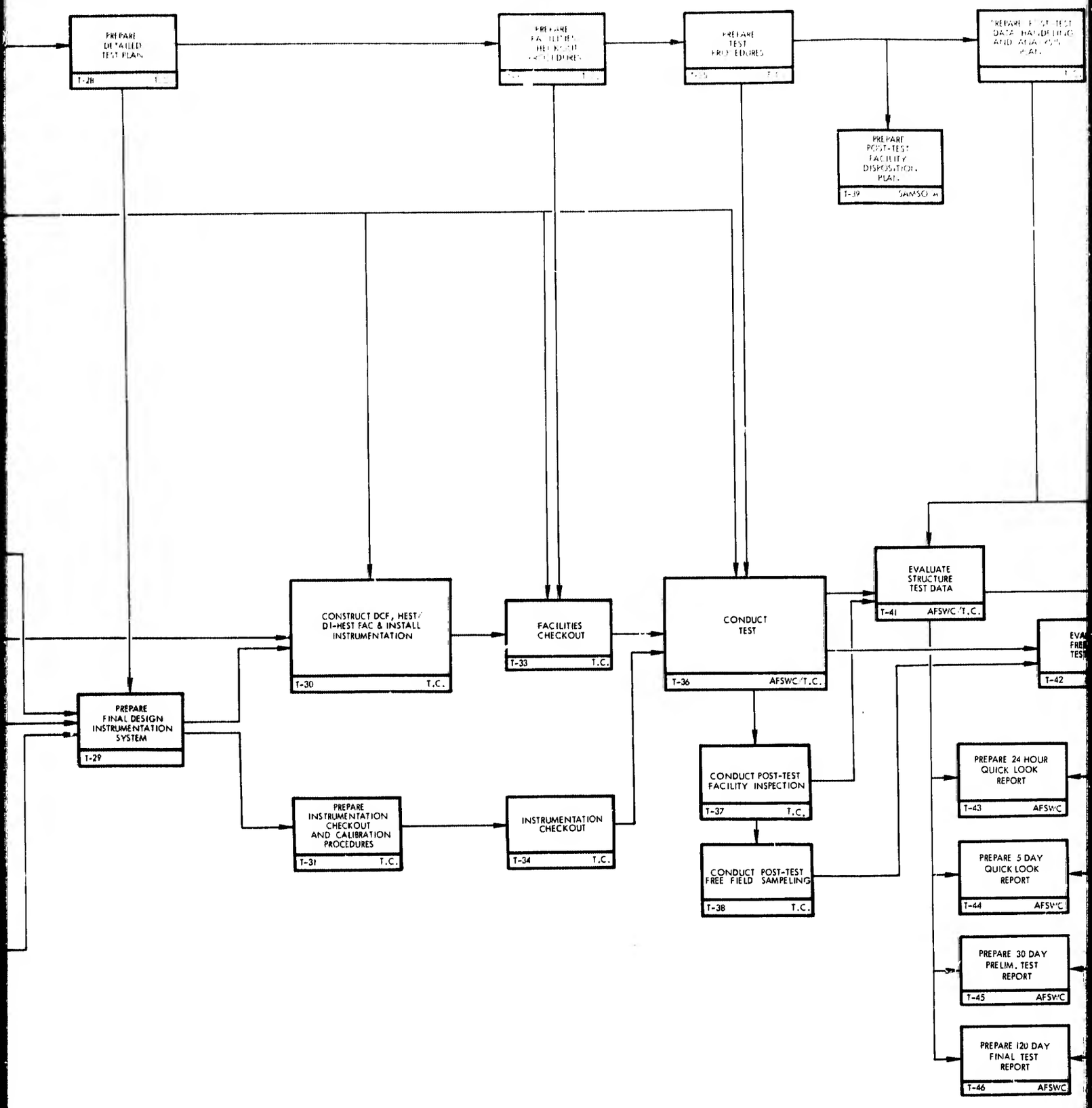



**Figure 3-1. Test Program Task Outlin**

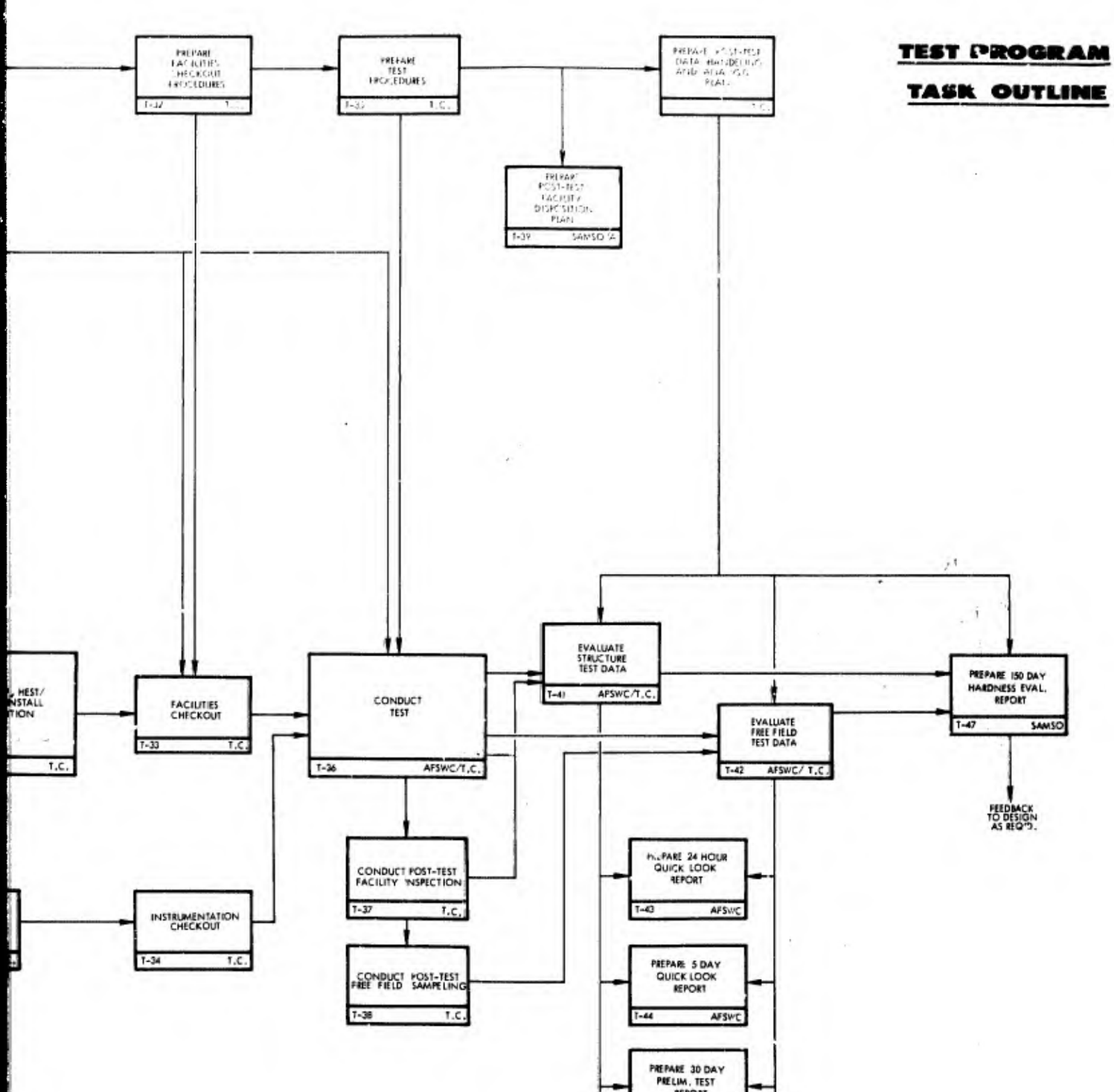



**Figure 3-1. Test Program Task Outline**

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T-7. Prepare Test Environment Criteria.

Utilizing the Operational Weapons Effects Environment Criteria, identify the specific environment components magnitudes and characteristics to be simulated in this Test Program.

T-8. Prepare Preliminary Selected LF Subsystems Design Criteria.

Utilizing the Operational Weapon System design criteria (as available), develop a criteria for the design of the selected LF subsystems to be used as test articles.

T-9. Prepare Test Site Selection Plan.

Based on the Test Site Selection Criteria, establish a logical method by which candidate test sites can be identified and examined, how the medium will be sampled, tested and evaluated.

T-10. Evaluate Test Sites and Make Selection Recommendations.

Proceed to examine and evaluate each of the candidate test sites and make recommendations for selection of the site in the Site Evaluation Report (D-9).

T-11. Select Test Site.

Based on the evaluations and recommendations presented in the Site Evaluation Report, SAMSO/Aerospace will identify the test site to be developed.

T-12. Prepare Pretest Analysis and Predictions Plan.

Identify and publish in the Pretest Analysis and Predicting Plan, the free field environment and structural response predictions required, and the analytical techniques that will be used to achieve the predictions.

T-13. Conduct Free Field Environment Simulation Analysis.

Determine the physical characteristics of the test facilities required to produce the environment specified in the Test Environment Criteria. Determine the degree to which the test facility can produce the required environment characteristics.

T-14. Conduct Scaling Analysis and Trade Studies.

Perform the analytical studies required to determine the relative merits of scaling down the test articles rather than providing the required environment for a full scale structure. Determine the scaling factors and recommend what is judged to be the most cost-effective scale.

T-15. Prepare Test Facility and LF Systems Design Criteria.

Utilizing the results of Tasks T-12 and T-13, establish the detailed criteria for the design of each LF Subsystem test article.

T-16. Prepare Initial Data Measurement Requirements.

From the Test Objectives and Success Criteria specified in the Test Program Plan, develop an initial listing of all test data requirements. It will contain enough information so that it can be used to size the complete instrumentation system.

T-17. Prepare Instrumentation Plan.

Utilizing the initial data requirements list, prepare an overall plan for the instrumentation of the free field and test article.

T-18. Prepare Instrumentation System Design.

Using the Initial Data Requirements List as a basis, develop a preliminary design of the total instrumentation system with emphasis on defining long lead time items. The design will include consideration of free field and structural response sensing and recording, photographic documentation, instrumentation location, timing and control, and power supply.

T-19. Prepare and Maintain Tier I Schedule.

At regular intervals, prepare and publish a top level schedule covering key program milestones.

T-20. Prepare and Maintain Tier II Schedule.

At monthly intervals prepare and publish a schedule of tasks to be accomplished in the succeeding 90 days.

T-21. Prepare Monthly Progress Report.

Document on a monthly basis, the progress of the Test Program from its inception until complete.

T-22. Design HEST/DI-HEST Facility

In accordance with the Test Facility Design Criteria, develop the design of the physical structure that is to provide the overpressure and ground motion environments required.

T-23. Prepare Free Field Environment Prediction.

Analytical techniques will be used to predict response motions at selected locations in the free field. The analytical techniques used and the locations selected will provide the basis for the free field test data measurement requirements. The test data will be used to evaluate and/or confirm analytical prediction techniques.

T-24. Prepare Free Field Instrumentation List.

This task will be accomplished in conjunction with and in response to Task T-23. Details of the instrumentation will be prescribed here to support the measurement of data at the locations specified in T-23. Measurement and recording devices will be defined to accommodate the predicted magnitude and characteristics of each of the specified measurements.

T-25. Design LF Subsystem Test Articles.

In accordance with the LF Subsystems Design Criteria, develop the design for each of the LF subsystem test articles to be tested. These include the silo structure, penetrations, main closure, and MF antenna system.

T-26. Prepare LF Subsystems Structural Response Predictions.

Utilizing the design analysis for each subsystem, and the predicted free field environment, use analytical techniques to predict structural response at selected locations on each LF subsystem. This will provide the basis for the structure test data measurement requirements. The test data will then be used to evaluate and/or confirm analytical prediction techniques.

T-27. Prepare LF Structure Instrumentation List.

This task will be accomplished in conjunction with and in response to Task T-26. Details of the instrumentation will be prescribed here to support the measurement of data at locations specified in T-26. Measurement and recording devices will be defined to accommodate the predicted magnitude and characteristics of each of the specified measurements. This task should be done in a timely manner so that wherever possible, provisions can be made to integrate the instrumentation in the design and fabrication of the subsystems.

T-28. Prepare Detailed Test Plan.

Utilizing the information generated in the previous tasks, prepare and publish a test plan that prescribes in detail the purpose of the test, the test objectives, success criteria, data measurement requirements, test configuration, go/no-go criteria, and test responsibilities.

T-29. Prepare Final Instrumentation System Design.

Using the instrumentation lists from Tasks T-24 and T-27, and the Preliminary Design from Task T-18, develop the final, detailed design for the instrumentation system including specification of type and location of sensors, cabling, conditioning and recording equipment, power supply, control equipment, recording speeds, etc. Specific details on integration of the instrumentation during fabrication or construction of the LF subsystems will be provided, as well as all requirements for cable runs, shock mounting of equipment, shielding and grounding requirements will be specified.

T-30. Construct the LF Structure, the HEST/DI-HEST Facility and Install Instrumentation.

Fabrication of LF subsystems and construction of the silo structure and the HEST/DI-HEST facility will be accomplished in a workmanlike manner, using construction techniques that can be expected to be used at the the operational sites. Care will be exercised in the installation of the instrumentation system so that the required measurements will be made accurately and with minimum of measurement dropouts.

T-31. Prepare Instrumentation Checkout and Calibration Procedures.

Detailed procedures for the pretest checkout and calibration of all instrumentation will be prepared and published.

T-32. Prepare Facilities Checkout Procedures.

Detailed procedures for the pretest checkout and the LF subsystems, the HEST/DI-HEST facility, safety communication and control systems, and instrumentation systems will be prepared to assure a successful test conduct.

T-33. Facilities Checkout.

Pretest checkout of all facilities and systems will be conducted in accordance with the Facilities Checkout Procedures (D-15).

T-34 Instrumentation Checkout.

Conduct instrumentation pretest checkout and calibration in accordance with the procedures specified in the instrumentation checkout procedures document (D-14).

T-35. Prepare Test Procedures.

Detailed procedures for the conduct of the test will be generated to assure a methodical accomplishment of all tasks directly associated with the conduct of the test. This will include a countdown sequence document, safety check list, go/no-go procedures, and hangfire procedures.

T-36. Conduct Test.

Implement the tasks specified in the Test Procedures (D-16) to accomplish the test conduct.

T-37. Post Test Facility Inspection.

The post test inspection of the LF subsystems and the surrounding free field will be conducted in accordance with the Facilities Checkout Procedures (D-15), to determine the effects of the test on the physical or functional condition of all elements in the test.

T-38. Post Test Free Field Sampling.

Core samples will be taken at selected locations in the free field in accordance with the Facilities Checkout Procedures (D-15).

T-39. Prepare Post Test Facility Disposition Plan.

The orderly wrap-up of the Test Program or the refurbishment of the facility for subsequent tests will be specified by a series of tasks published in the Facility Disposition Plan (D-17).

T-40. Prepare Post Test Data Handling and Analysis Plan.

A plan will be prepared to describe the procedures to be used for the collection, reduction, evaluation and analysis of all free field and structural data taken before, during and after the test event.

T-41. Evaluate Structure Test Data.

Structural response test data recorded during the event will be evaluated with respect to the predicted structural response values and the prescribed test objective success criteria. Causes for any discrepancies will be identified, and structural failures will be investigated. The results of the structural evaluation will be provided as required for the test reports.

T-42. Evaluate Free Field Test Data.

Free field environment test data recorded during the test event will be evaluated with respect to the predicted environment (or free field response) values and the prescribed test objective success criteria. Causes for discrepancies will be identified. The free field test data evaluations will be provided as required for the test reports.

T-43. Prepare 24-Hour Quick Look Report.

Preliminary test results will be summarized and by the test conductor in a TWX report 24 hours after the test event.

T-44. Prepare 5-Day Quick Look Report.

Additional preliminary test results in support of the 24-hour TWX will be issued by the test conductor 5 days after the test event. It will contain preliminary free field and structural response test data.

T-45. Prepare 30-Day Preliminary Test Report.

The test conductor will prepare and issue a test report containing the results of the test data evaluation to that date. This will include an evaluation of the test data with respect to the predicted values.

T-46. Prepare 120-Day Final Test Report.

A final report will be issued by the test conductor 120 days after the test event. It will include all test data and evaluations along with an assessment of the degree to which this test achieved the desired results.

T-47. Prepare 150-Day Hardness Evaluation Report.

A final report that reflects the degree of confidence in the hardness of the LF subsystem elements tested will be published by SAMSO/Aerospace 150 days after the test event.

## 3.2 TEST PROGRAM DOCUMENTATION

The management and control of the test program is dependent on the publication and use of a number of key test program documents. These key documents are shown in Figure 3-2, Test Program Document Tree, and are briefly described in the following paragraphs:

### D-1. In-Place Hardness Test Program Plan

The purpose of the In-Place Hardness Test Program Plan is to prescribe a spectrum of testing that will provide high confidence in the hardness of all elements of the weapon system. The plan includes:

a) Summary flow of required tests

b) Test program schedule

c) Descriptions of required tests.

### D-2. LF Subsystems Test Plan

The purpose of the LF Subsystems Test Plan is to describe the LF Subsystems HEST/DI-HEST Test Program in terms of:

a) Test article configuration

b) Simulation technique

c) Test objectives/success criteria

d) Test Program tasks

e) Test Program documentation

f) Test Program schedule

g) Test Program responsibilities.

### D-3. Tier I Schedule

The purpose of the Tier I schedule is to present the key milestones of the Test Program on a gross time scale. The schedule will include:

a) Program start and target completion date

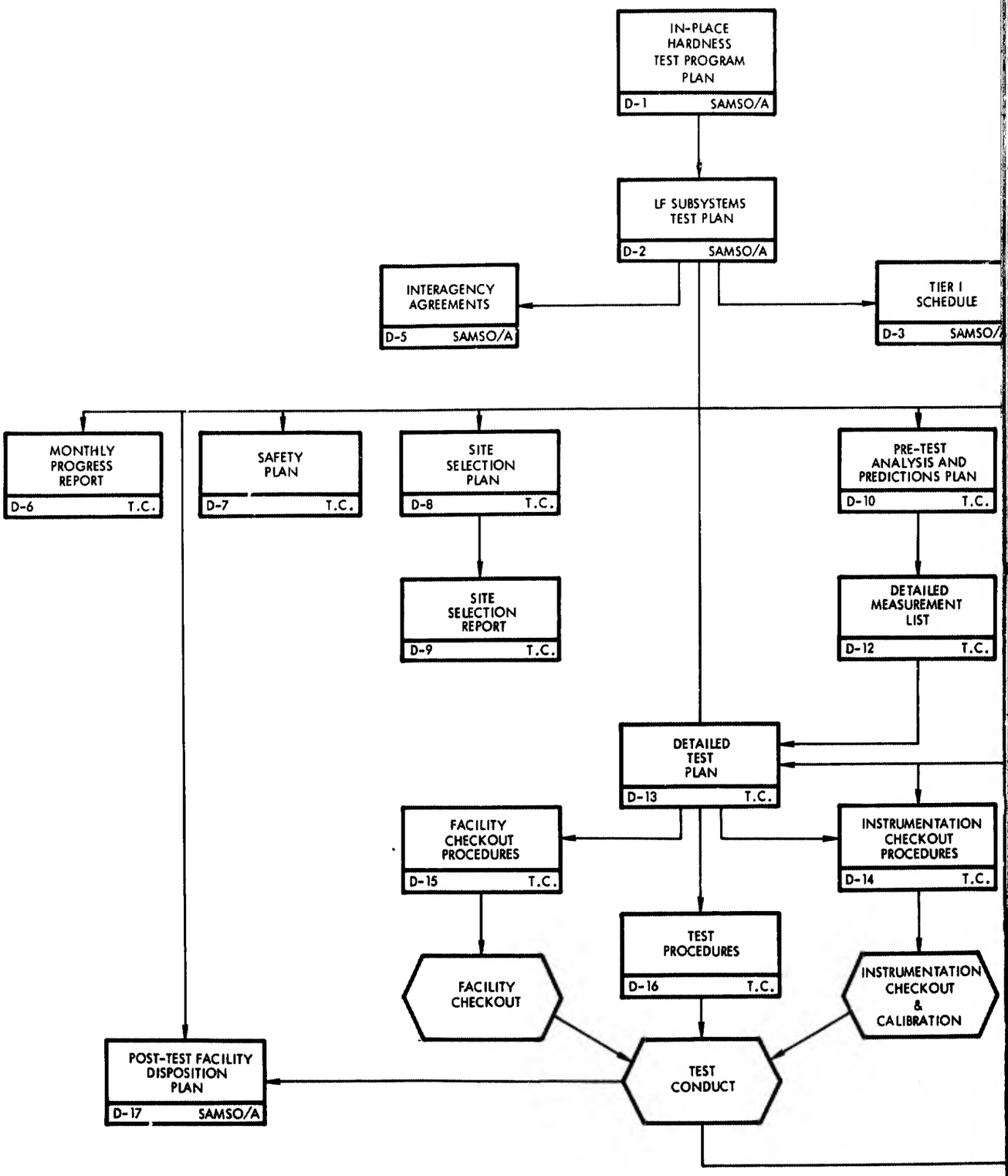
b) Target test event date

c) Facility construction start and completion dates

d) Key analysis and software delivery dates.

### D-4. Tier II Schedule

The purpose of the Tier II Schedule is to present a more detailed time phasing of Test Program tasks within the big milestone base provided by the Tier I Schedule. The Tier II Schedule will be released monthly and will schedule the activities for succeeding 90-day periods.


IN-PLACE HARDNESS TEST PROGRAM PLAN
D-1 SAMSO/A
LF SUBSYSTEMS TEST PLAN
D-2 SAMSO/A
INTERAGENCY AGREEMENTS
D-5 SAMSO/A
TIER I SCHEDULE
D-3 SAMSO/
MONTHLY PROGRESS REPORT
D-6 T.C.
SAFETY PLAN
D-7 T.C.
SITE SELECTION PLAN
D-8 T.C.
PRE-TEST ANALYSIS AND PREDICTIONS PLAN
D-10 T.C.
SITE SELECTION REPORT
D-9 T.C.
DETAILED MEASUREMENT LIST
D-12 T.C.
DETAILED TEST PLAN
D-13 T.C.
FACILITY CHECKOUT PROCEDURES
D-15 T.C.
INSTRUMENTATION CHECKOUT PROCEDURES
D-14 T.C.
TEST PROCEDURES
D-16 T.C.
FACILITY CHECKOUT
INSTRUMENTATION CHECKOUT & CALIBRATION
POST-TEST FACILITY DISPOSITION PLAN
D-17 SAMSO/A
TEST CONDUCT

Figu

A.

## TEST DOCUMENTATION TREE

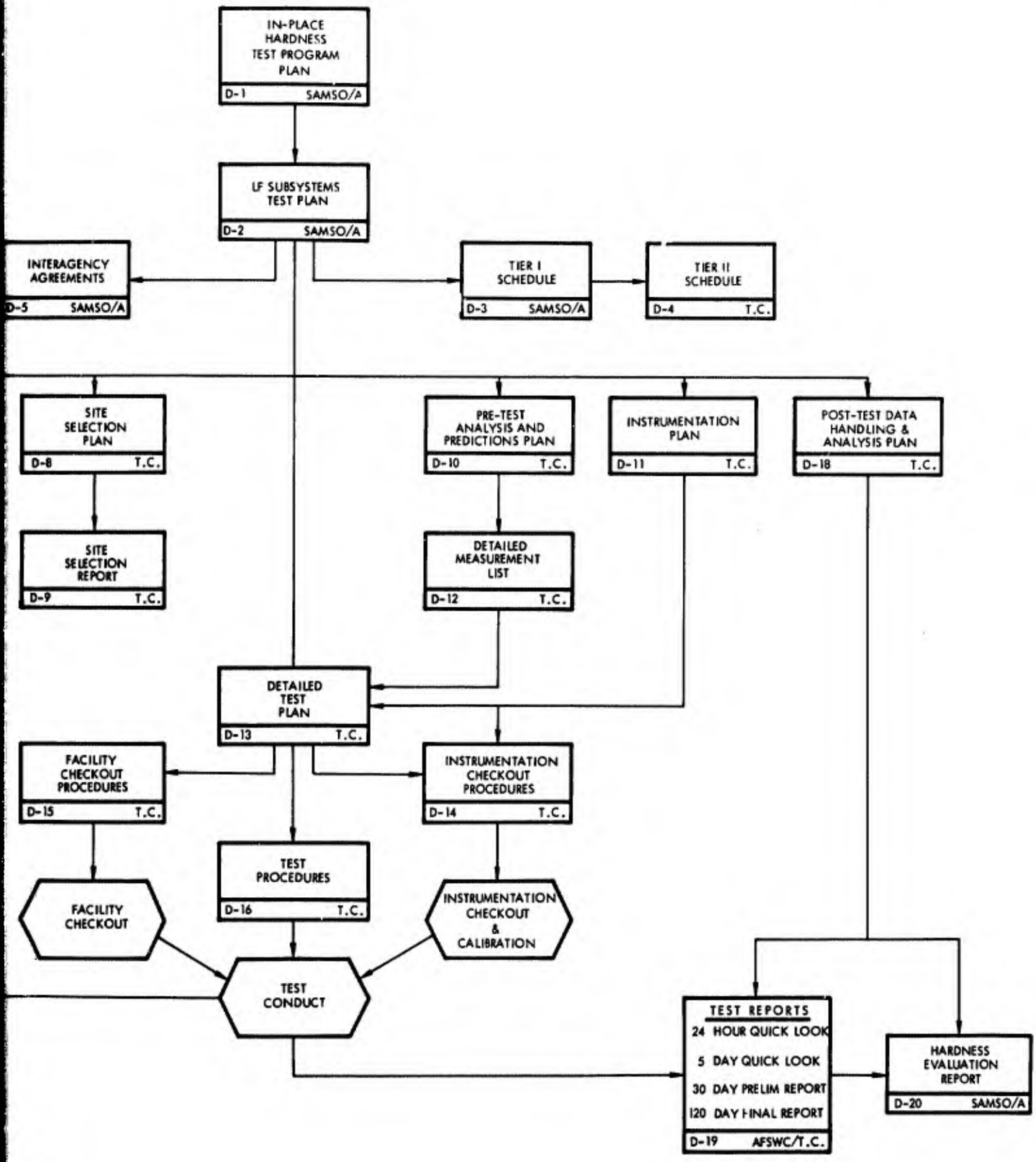



Figure 3-2. Test Documentation Tree



B.

## D-5. Interagency Working Agreements

The purpose of the Interagency Working Agreements document is to package together all of the management and working agreements or memoranda developed by the affected government agencies. The document will include agreements describing the relationships between:

a) AFWL and AFSWC

b) AFSWC and USA/WES

c) AFSWC and SAMSO

## D-6. Monthly Progress Report

The purpose of the Monthly Progress Report is to present and record a cumulative account of the Test Program progress from inception to completion. The report will include a record of:

a) Key milestones achieved

b) Tasks accomplished

c) Problems encountered

d) Evaluation of progress with respect to the program schedule.

## D-7. Safety Plan

The purpose of the Safety Plan is to prescribe the measures that will be taken to insure safety in all phases of the test program. The Safety Plan includes:

a) Safety criteria for test site selection

b) Site sampling safety

c) Construction safety

d) Ordnance systems safety

e) Test conduct safety

f) Post test safety.

## D-8. Site Selection Plan

The purpose of the Site Selection Plan is to outline the methods to be used in the examination testing and evaluation of candidate test sites to meet the conditions specified in the Site Selection Criteria. The plan will include:

a) List of candidate sites

b) Description of analytical techniques to be used

c) Test site sampling plan

d) Tradeoffs to be performed.

D-9. Site Selection Report

The purpose of the Site Selection Report is to record all of the considerations involved in the evaluation of the candidate test sites, to present conclusions and to list the recommended test site. The report will include:

a) Test site candidates

b) Considerations and selection criteria

c) Site sampling data

d) Trade studies

e) Conclusions

f) Recommended test site.

D-10 Pretest Analysis Plan

The purpose of the Pretest Analysis Plan is to outline the manner in which the pretest analysis of both the environment facility and the LF structures will be accomplished. The plan will prescribe the requirement for and the method of accomplishing:

a) Free field environment predictions

b) Structural response predictions.

D-11. Instrumentation Plan

The purpose of the Instrumentation Plan is to identify at an early stage in the program, the scope and characteristics of the data at will be required to satisfy the objectives of the program and manner in which the data will be measured and recorded. This initial plan will be used to define the instrumentation system design criteria, and will include:

a) Postulated free field data measurement list

b) Postulated structure response data measurement list

c) Postulated photographic requirements

d) Pre and post test data requirements

e) Data measurement and recording techniques

f) Instrumentation system description

g) Instrumentation system development schedule

h) Instrumentation system support requirements

i) Measurement and recording device locations and installation techniques.

## D-12. Detailed Measurements List

The purpose of the Detailed Measurements List is to provide specific, detailed measurement requirements keyed to the free field environment predictions and the structural response predictions so that final adjustments may be made in the instrumentation system design. The Detailed Measurement List will include:

a) Free field data measurement requirements

b) Structural response data measurement requirements.

## D-13. Detailed Test Plan

The purpose of the Detailed Test Plan is to describe the LF Subsystems Test in sufficient detail so that all required test procedures can be prepared and the test conducted in a manner that produces the required test results. The Detailed Test Plan will prescribe:

a) Test descriptions

b) Test objectives/success criteria

c) Data requirements

d) Test article configuration

e) Test (environment) facility configuration

f) Test prerequisites

g) Go/no-go criteria

h) Test responsibilities.

## D-14. Instrumentation Checkout Procedures

The purpose of the Instrumentation Checkout Procedures is to assure that all elements of the instrumentation system are properly installed and calibrated so that the data obtained during the test event will be valid. The procedures will include:

a) Calibration procedures

b) Dry-run procedures

c) Pretest checklist.

## D-15. Facilities Checkout Procedures

The purpose of the Facilities Checkout Procedures is to assure that the environment facility and test article configurations are as required to obtain the desired test results. The Facilities Checkout Procedures will include:

a) Critical environment facility configuration check points

b) Critical LF subsystems configuration checkpoints.

## D-16. Test Procedures

The purpose of the Test Procedures document is to assure that the conduct of the test proceeds in an orderly, efficient, and safe manner such that there is a high probability of obtaining the desired test results. It will assure that the prescribed test objectives are not compromised because of a procedural problem, and will include:

a) Countdown manual

b) Go/no-go procedures

c) Contingency procedures in the event of a hangfire

## D-17. Post Test Facility Disposition Plan

The purpose of the Post Test Facility Disposition Plan is to prescribe the specific actions to be taken to either wrap up the test and abandon the facility, or to initiate refurbishment of the facility for subsequent testing.

## D-18. Post Test Data Handling and Analysis Plan

The purpose of the Post Test Data Handling and Analysis Plan is to describe the test data flow subsequent to the test event and to prescribe the data reduction and analysis techniques to be used. This will provide for optimum utilization of the test results and will assure proper use of the test data in correlation with the free field environment and structural response predictions.

## D-19. Test Reports

A series of four test reports will be published by the Test Force Organization subsequent to the test event. These reports will begin with a TWX report of the test highlights, with each subsequent report becoming more detailed. The test reports will present all data and evaluations and provide an assessment of the degree to which the test achieved the desired results. The test reports will include:

a) 24-hour Quick Look report

b) 5-day Quick Look report

c) 30-day Preliminary report

d) 120-day Final Test report.

## D-20. Hardness Evaluation Report

The Hardness Evaluation Report will be published 150 days after the test event. It will evaluate the LF subsystems and will provide an assessment of the degree to which each subsystem element can be expected to survive the operational weapons effects environment, based on the results of the test.

## 3.3 TEST PROGRAM SCHEDULE

The tasks outlined on Figure 3-1 and the key test documents shown on Figure 3-2 are phased together with key program milestones on the Test Program Schedule (Figure 3-3). It should be noted that the schedule presented in this document can only be updated when the document is revised. After this document has been published and the program has been initiated, refer to the Tier I Schedule (published as required), and Tier II Schedule (published monthly) for accurate scheduling information.

## 3.4 TEST FORCE ORGANIZATION

The Test Force Organization is depicted in Figure 3-4. The functions and responsibilities of each participant are described in the following paragraphs:

### 3.4.1 Test Director (SAMSO)

The USAF Space and Missile Organization as Test Director has the responsibility for the overall management of the test program. The functions of the Test Director include:

a) Provide program funding
b) Establish program milestones
c) Define program objectives
d) Provide design and development criteria
e) Provide the chairman for the Test Working Group.

### 3.4.2 General Systems Engineering (Aerospace)

The Aerospace Corporation, as General Systems Engineering Contractor, will provide technical support to the Test Director during all phases of the test program. The functions of the GSE contractor include:

a) Provide technical support as required
b) Develop Work Statements for Test Program contractors
c) Develop design and test criteria documents
d) Monitor the technical progress of the test participants
e) Perform design and test result evaluations as required.

INITIATE TEST PROGRAM (SAMSO

T-1 PUBLISH TE
T-2 INITIATE T
T-3 ESTABLISH
T-4 SELECT CO
T-19 PUBLISH T

PUBLISH TEST CRITERIA (SAMSO/

T-6 TEST SITE SE
T-7 TEST ENVIRO
T-8 PRELIMINAR
T-15 TEST ENVIRO

SITE SELECTION

T-9 PREPARE TES
T-10 EVALUATE T
T-11 SELECT TEST

PRE-TEST ANALYSIS, DESIGN & P

T-13 FREE FIELD
T-14 SCALING A
T-22 HEST DI-HE
T-23 FREE FIELD E

T-25 LF STRUCTU
T-26 LF STRUCTU

INSTRUMENTATION PLANNING

T-16 INITIAL DA
T-17 INSTRUMEN
T-18 INSTRUMEN
T-24 FREE FIELD
T-27 LF STRUCTU
T-29 INSTRUMEN
T-31 INSTRUMEN

TEST PLANNING & PROCEDURES

T-12 PRE-TEST AN
T-11 SAFETY PLA
T-28 DETAILED TE
T-32 FACILITIES
T-35 TEST PROCE
T-39 POST TEST P
T-40 POST TEST D

FACILITIES CONSTRUCTION, INS

T-30 FACILITIES C
T-33 FACILITIES C
T-34 INSTRUMEN

CONDUCT TEST

T-36 TEST CONDU

POST TEST DATA EVALUATION &

T-37 POST TEST FA
T-38 POST TEST FA
T-41 STRUCTURAL
T-42 FREE FIELD D
T-43 46 TEST RE
T-47 HARDNESS E

POST TEST FACILITY DISPOSITION

DISPOSAL OR REFU

A.

## TEST PROGRAM SCHEDULE

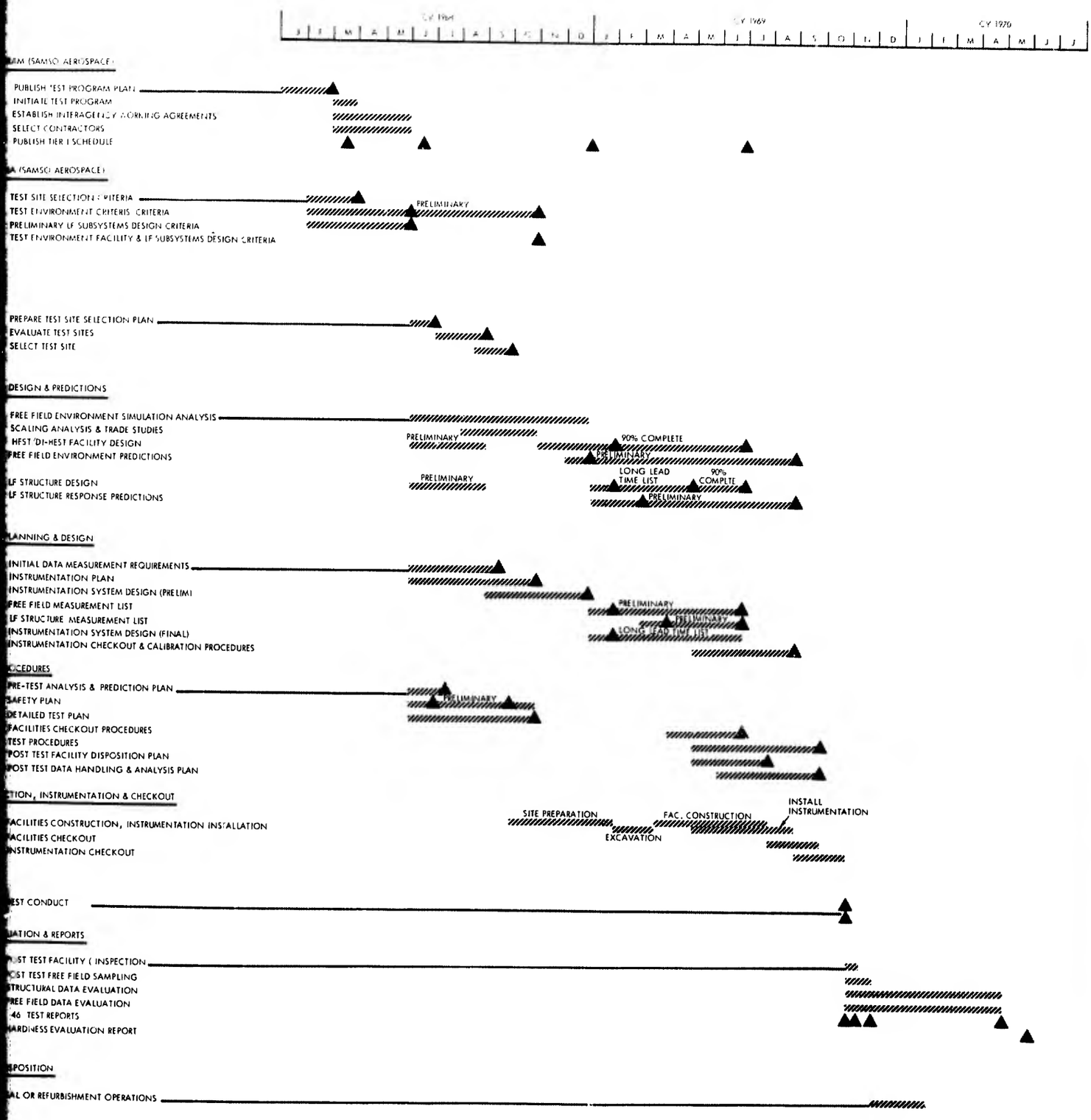



**Figure 3-3. Test Program Schedule.**



B.

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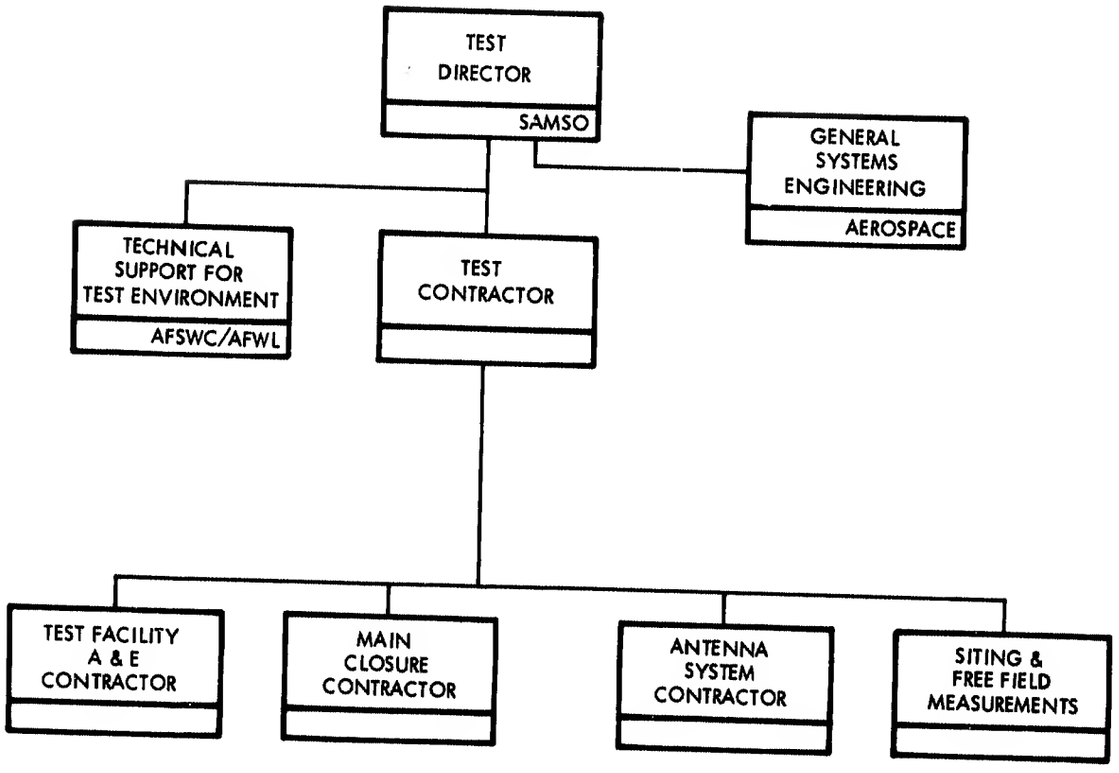


**Figure 3-4. Test Forces Organization**

### 3.4.3 Technical Consultant for Test Environment (AFSWC/AFWL)

The USAF Air Force Special Weapons Center, and the Air Force Weapons Laboratory will be responsible to SAMSO for technical support in the area of environment facility development. The functions of the Technical Consultant to AFSWC will include:

a) Participate in the Test Working Group

b) Provide technical support in the development of the HEST/DI-HEST facility design criteria

c) Provide technical cognizance on the development of free field and structural response predictions

d) Provide technical cognizance over instrumentation design and installation.

### 3.4.4 Test Contractor

The Test Contractor will be responsible to the Test Director for the implementation of all technical and nontechnical test support activities in accordance with the contractor's Statement of Work. The functions performed by the Test Integrating Contractor include:

a) Participate in the Test Working Group

b) Direct all test and test support activities

c) Provide technical support in the selected areas

d) Provide pre and post test analysis and data evaluation

e) Conduct test

f) Direct post test inspections and sampling tasks

g) Direct test program wrap up

h) Publish test reports

i) Assume prime responsibility for the accomplishment of Tasks T-5, T-9, T-10, T-12, T-16, T-18, T-20, T-21, T-24, T-25, T-26, T-27, T-28, T-29, T-30, T-31, T-32, T-33, T-34, T-35, T-36, T-37, T-38, T-39, T-40.

j) Participate with AFSWC and AFWL in the accomplishment of Tasks T-13, T-14, T-19, T-22, T-23, T-42, T-44, T-45, T-46.

k) Participate with SAMSO and Aerospace in the accomplishment of Tasks T-31, T-6, T-7, T-8, T-11, T-15, T-39, T-47.

### 3.4.5 A and E Contractor

The Architectural and Engineering Contractor will be responsible to the Test Integration Contractor, in accordance with the Contractor's Statement of Work, for the design and construction of the environment facility and the LF structure.

### 3.4.6 Main Closure Contractor

The Main Closure Contractor will be responsible to the Test Integration Contractor, in accordance with the Contractor's Statement of Work, for the design and fabrication of the main closure system.

### 3.4.7 Antenna Systems Contractor

The Antenna Systems Contractor will be responsible to the Test Integration Contractor, in accordance with the Contractor's Statement of Work, for the design, fabrication and installation of the antenna system.

### 3.4.8 Site Investigation Contractor

The Site Investigation Contractor will be responsible to the Test Integration Contractor, in accordance with the Contractor's Statement of Work (or in the case of a Government agency, the interagency agreement), for the tasks associated with test site examination, sampling and evaluation. The Site Investigation Contractor will also provide selected free field instrumentation for the test event.

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## ABBREVIATIONS

| | |
|---|---|
| AEC | Atomic Energy Commission |
| AES | Air Entrainment System |
| AFSWC | Air Force Special Weapons Center |
| AFWL | Air Force Weapons Laboratory |
| AGE | Aerospace Ground Equipment |
| AVE | Aerospace Vehicle Equipment |
| BV | Blast Valve |
| CBR | Chemical, Biological, and Radiological |
| CDR | Critical Design Review |
| CG | Center of Gravity |
| DASA | Defense Atomic Support Agency |
| DI | Direct Induced |
| DIHEST | Direct Induced High Explosive Simulation Technique |
| DOD | Department of Defense |
| EC | Equipment Capsule |
| ECU | Environmental Control Unit |
| E-M | Electric and Magnetic |
| EMP | Electromagnetic Pulse |
| ERDL | Engineering Research and Development Laboratories |
| ESA | Electrical Surge Arrestor |
| FAC | Facility |
| GTM | Ground Test Missile |
| HE | High Explosive |
| HEST | High Explosive Simulation Technique |
| HET | High Explosive Test |
| HF | High Frequency |
| HPT | Hardness Proof Test |
| IITRI | IIT Research Institute |
| LASL | Los Alamos Scientific Laboratory |
| LCF | Launch Control Facility |
| LF | Launch Facility |
| MC | Main Closure |
| MF | Medium Frequency |

## ABBREVIATIONS (Continued)

| | |
|---|---|
| NEST | Nuclear Explosive Shock Tube |
| NTS | Nevada Test Site |
| NWSSG | Nuclear Weapon System Safety Group |
| OGE | Operating Ground Equipment |
| OP | Operational |
| PC | Personnel Capsule |
| PDR | Preliminary Design Review |
| PSI | Pounds per Square Inch |
| PTPD | Preliminary Test Development Plan |
| RF | Radio Frequency |
| SAC | Strategic Air Command |
| SAMSO | Space and Missile Systems Operation |
| SI | Shock Isolator |
| SOR | System Operational Requirement |
| SOW | Statement of Work |
| SPUD | Synthetic Pulse Diagnosis |
| TRA | Test Requirements Analysis |
| TREES | Transient Radiation Effects, Electronics System |
| TSE | Test Support Equipment |
| UHF | Ultra High Frequency |
| WES | Waterways Experiment Station |

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| 11 SUPPLEMENTARY NOTES | 12 SPONSORING MILITARY ACTIVITY |
|---|---|
| | |

13 ABSTRACT

This study has developed a test program plan for demonstrating the in-place hardness of an advanced ballistic missile weapon system. A test requirements analysis methodology was devised, utilizing a systems approach, to examine a WS-120A system baseline design with respect to a given weapons effect environment criteria, define the testing required to assure hardness of each system element, trade off applicable simulation techniques, and recommend a series of test concepts. These concepts were then logically combined into efficient and cost-effective in-place hardness demonstration test programs for the launch facility and launch control facility.

This report has been divided into five volumes and classified as follows:

| | |
|---|---|
| Volume I | Study Report Summary (Unclassified) |
| Volume II | Methodology (Unclassified) |
| Volume III | Test Requirements Analysis (Secret, RD) |
| Volume IV | Test Program Plan (Unclassified) |
| Volume V | Selected LF Subsystems Test Plan (Unclassified) |

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| In-Place Hardness Demonstration<br>Test Requirements Analysis<br>LF and LCF Hardness Test Plan<br>Test Concept | | | | | | |

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